INTEGRATION OF ICT IN THE TEACHING OF SCIENCE: AN INVESTIGATION OF 45 PRIMARY SCHOOL TEACHERS

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Abstract

The research was carried out in order to find out how do the teachers integrated ICT in the Science lessons in primary schools in the Sarikei District, Sarawak. The data collected through using questionnaires and interviews. Forty five teachers who teach Science subject were randomly selected from 172 Science teachers in Sarikei District as respondents in this study. SPSS programme is used to analyze data to obtain frequency, percentage, mean and standard deviation. The result will benefit the educational administers in planning activities and programmes catering to the needs of teachers to enhance the teacher professionalism.

The findings showed that the level of integrated ICT in the Science lessons in primary schools is still low. They showed good perception toward computer usage in teaching and learning. The finding also shows the skill of using computer is still at the low level. The research also showed the problems which teachers are facing in teaching and learning science in class.

The implication of the findings also discussed in this study. It is hoped that the research can give a general idea about the level of integration of ICT among science teachers. Beside that, it is also hoped that the computer skills among primary school science teachers can be improved.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Malaysia is one of the fastest developing nations in South East Asia. Indeed, it has a national ambition called Vision 2020, the purpose of which is to attain developed-nation status by the year 2020 (Mahathir, 1998). Introducing Vision 2020 would be a big step towards Malaysia's attainment internationally of the status of an industrialised and a developed nation. The former Prime Minister, Datuk Seri Dr. Mahathir Mohammed, stressed that Malaysia should not only be developed economically, but that it should be a nation that would be developed politically, socially, spiritually, psychologically and culturally as well. To do this, Malaysia needs to overcome nine strategic challenges encompassed in Vision 2020 (Appendix 1). One of these targets is that Information Technology (IT) as a priority investment if Malaysia is to become a developed nation by the year 2020. This sixth of the nine central strategy challenges of Vision 2020 states that

> *Malaysia must establish a scientific and progressive society, a society that is innovative and forward looking, one that is not only a consumer of technology but also a contributor to the scientific and technological civilisation of the future. (Mahathir Mohammad, 1998, p.16)*

Malaysian leaders accept the importance of IT to enhance productivity, efficiency and competitiveness because IT is connecting people around the world.

1.1 Background Of The Study

1.1.1 Multimedia Super Corridor (MSC)

To achieve the substance of Vision 2020, the government has set up a blueprint for the MSC. The MSC is a massive 750-square-kilometer high-tech information zone encompassing the Kuala Lumpur City Center(KLCC), Putrajaya (administrative center) and the Kuala Lumpur International Airport (KLIA). The infrastructure of the MSC area emphasises what the Prime Minister has described as providing high-powered networking, efficient transportation, satellite telecommunications and intercity connections (Mahathir Mohammad, 1998).

To spearhead the development of the MSC and give shape to its environment, seven initiatives for multimedia applications have been identified. These initiatives are borderless marketing, smart schools, electronic government, multi-purpose card, telemedicine, research and development and worldwide manufacturing webs. Of these, the smart school initiative is regarded by the former Prime Minister as a specific response to Malaysia's need to make the critical transition from an industrial economy to a knowledge-based society (Mahathir Mohammad, 1998). This initiative would enable Malaysia to produce skilled people who would be able to harness the benefits and the potential of IT needed to attain the "smart" Malaysian society in 2020.

1.1.2 The Smart School

The Government of Malaysia aims to capitalise on the presence of leading-edge technologies and the rapid development of the MSC's infrastructure to jumpstart deployment of enabling technology to schools. A group of 84 Smart Schools was created by the Ministry of Education in 1999 as pilot schools, which are a sampling of a range of schools nationally (Smart School Project Team, 1997).

The Smart School Project Team (1997) has defined the Malaysian Smart School as a learning institution "reinvented in terms of teaching-learning practices and school management in order to prepare children for the Information Age" (p.20). The teaching-learning practices would be different from conventional ones that are currently being practiced. The teaching methods would emphasis the use of specific goals that could be achieved through differing modes such as alone, in pairs, in small teams, with an expert or even within a computer-based multimedia simulation. The learners are encouraged to engage in an active learning environment where they construct and participate in the learning process. To promote this kind of environment, there would be an appropriate mix of learning strategies, ranging from a completely teacher-centered method to a student-centered one.

The goals of the Smart School initiative focus on the development of a skilled work force for the Information Age. The National Philosophy of Education (Ministry of Education, 1999) puts the goals this way:

> *Education in Malaysia is an on-going effort towards further developing the potential of individuals in a holistic and integrated manner, so as to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious, based on a firm belief in and devotion to God. Such an effort is designed to produce Malaysian citizens who are knowledgeable and competent, who possess high moral standards, and who are responsible and capable of achieving high levels of personal well-being as well as being able to contribute to the harmony and betterment of the family, the society and the nation at large.*

The Smart School Project Team in their report set five objectives:

a. all round development of the individual (intellectual, physical, emotional, spiritual);

b. the development of individual strengths and abilities;

c. the production of a thinking and technology-literate workforce;

d. a democrative form of education;

e. the increased participation of stakeholders.

The first two goals are targeted at the individual, the third goal relates to the needs of the society and finally the fourth and fifth goals are targeted at the system of education. To achieve the objectives, the key components of a Smart School include:

a. Teaching and Learning;

b. Management and Administration;

c. People, Skills and Responsibilities;

d. Technology Enablers;

e. Processes and Scenarios;

f. Policies.

1.1.3 Teachers And IT

The planned policy is that by the year 2010, all 10,000 of Malaysia's primary and secondary schools will be Smart Schools (Smart School Project Team, 1997). All teachers will, therefore, have to be able to use IT in the conversion process. They will change from being knowledge presenters to knowledge facilitators. As knowledge facilitators, rather than knowledge presenters, teachers will have certain roles that will be quite different from conventional classroom teaching practices (Computers in Education Development Unit, 1987). They will become, as Lai (1993) pointed out, planners and managers, participants and guides. These will be new roles to play. In Lai's view, for teachers to be planners and managers,

they will have to plan when setting up a computer-supported learning environment and will have to know how computer software can be integrated into the existing school curriculum. He also added that teachers will no longer be the knowledge authorities but instead will have to learn alongside the students. Lastly, teachers must be able to guide students so that they will have some metacognitive knowledge of the entire learning process in order to help students acquire thinking skills and construct knowledge.

The work of teachers should be emphasised as they will be the most important "teaching tools" in the implementation of the new technology. Hativa (1986) stressed that the work of the teacher is the crucial factor in implementing and maintaining an innovation. Ely (1987) commented similarly that educators, if they plan to use educational technology to the fullest, they ought to study the interacting roles of the teachers, the media and the environment.

IT skills will form an essential part of the general literacy skills of all teachers (Oliver, 1994a). He stressed that today's teachers must have a good command of computer technology in order to fulfill their new tasks in tomorrow's schools. Wood (1999), however, asserted that although technology might be relatively new, the ideas underpinning it are old and familiar to teachers. He further added that the design and aims of Information Technology and Communication (ICT) are strongly influenced by three longstanding traditions in educational philosophy and learning theory. Skinner's behaviourist theory, Piaget's cognitive theory and

Vygotsky's social theory are among the most influential ones. Wood (1999) contended that the use of computers together with the support of teachers to master small topics is a modern variant of Skinner's early work on teaching machines and behaviourist learning theory. The Piagetian perspective come into play when students are engaged in computer programming to enhance their understanding in a subject matter. Here, the students act as natural learners and learning occurs naturally. The Vygotskian perspective can be seen when the Internet is used to gather information from remote sites and to communicate with people from other locations.

Oliver (1994a) echoed his own views and those of his colleague Newhouse (1989) when he stressed that IT can significantly aid the teaching process when used as a productivity tool in planning, preparing and administering instructional programmes and sequences. Meanwhile (Pratt, 1993) had stated that IT can provide many advantages for improving the quality of teaching and learning environments and the development of higher order learning skills. Jones (1993) had also agreed that IT skills are important outcomes of all teaching and learning in much the same way as general literacy and numeracy have long been accepted as important outcomes of classroom teaching and schooling.

The Smart School Project Team (1997) stressed that a comprehensive teacher education programme, which introduces IT elements, will be critical to the success of the Smart School concept. Such an approach the Team said, will enable

teachers to carry out their responsibilities as facilitators in the classroom, by equipping them with specific IT knowledge and skills as well as the right attitudes toward IT. IT knowledge, skills and attitudes toward IT are the measurable variables normally used to represent the degree of teachers' preparedness to use IT in their teaching (Wild, 1995). In line with such measures of IT preparedness, the effectiveness of IT courses in initial teacher training programmes is typically described in terms of actual or perceived cognitive outcomes, as well as changes in attitudes and confidence (McFarlane and Jared, 1994; Oliver, 1994a).

Besides the three longstanding theories mentioned earlier, there are several learning theories and models which are directly related to IT. These new theories and models suggest that the degree of IT preparedness can be measured in terms of knowledge, skills and attitudes. They seem to direct the attention to these three variables when an interaction occurs between the machine and the human. In this research, Anderson's Adaptive Control of Thought (ACT) theory (1983), Davis' Technology Acceptance Model (TAM) (1989) and Wilson's framework (1992) provide a basis for determining IT knowledge, skills and attitudes as the main variables.

One of the most influential explanations of skills acquisition is Anderson's theory (1983). Essentially, Anderson distinguished the learning of a skill in relation to two different types of knowledge, which are known as declarative and procedural.

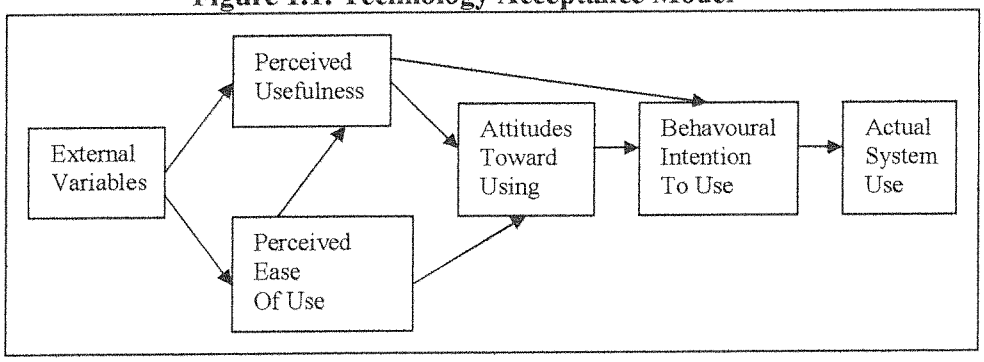
According to Anderson, declarative knowledge is what we call knowledge or propositions about what is true. It is a form of explicit memory and conscious efforts must be made to retrieve this information. Anderson also postulated that the skills that form the ability to carry out procedures correctly are procedural knowledge. It is a form of implicit memory and includes motor skills. The ACT theory attempts to show how cognitions actually produce action. In a simpler form, it means that skills acquisition involves knowledge and skills.

Closely related to this theory is the Technology Acceptance Model (TAM) introduced by Davis in 1989 (Davis, Bagozzi and Warshaw, 1989). It was developed to explain computer usage behaviour. The goal of TAM was to

> *provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behaviour across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified.*
> *(Davis et al., 1989,p.985)*

TAM (Figure 1.1) postulates that computer usage is determined by a behavioural intention to use a system which is jointly determined by a person's attitudes towards using the system and its perceived usefulness. This attitude is also jointly determined by perceived usefulness and perceived ease of use. According to TAM, perceived usefulness is influenced by perceived ease of use and external variables.

Figure 1.1: Technology Acceptance Model



(Source: Davis, et al.,1989, p.985)

This model posits that the use of an actual system, for example, a computer based one, is determined by the user's attitudes toward it. The actual use can be measured in terms of the user's knowledge and skills of the system (Speier, Morris and Briggs, 1997). Wilson (1992) made the connection between the three variables when he stressed that teachers' IT preparedness should be measured in terms of knowledge, skills and attitudes.

It has been planned that by the year 2010 all 10,000 of Malaysia's primary and secondary schools will be Smart Schools (Smart School Project Team, 1997). This means that in the next decade the entire population of teachers in Malaysia must be fully prepared to teach in Smart Schools nation-wide. The pressure on teachers to become IT literate as well as to understand the education implications of the new technology has, therefore, become urgent. For that reason, these teachers must be trained to be skilled and knowledgeable about IT with the right attitudes.

The Smart School Project Team (1997) stressed that a comprehensive teacher education training programme incorporating best practices in technology will enable teachers to carry out their responsibilities as facilitators in the classroom. Teachers, therefore, must be assessed thoroughly by the educational authorities before they teach in schools to determine if they are IT prepared. Local and foreign studies have been conducted to find out teachers' level of IT skills, knowledge or attitudes. (Ab Rahim Bakar and Shamsiah Mohamed, 1998; Sheffield, 1998 and Hughes, 1997). These local and overseas studies measured the teachers' knowledge and skills in terms of what they themselves perceived and not the actual level they actually had. In addition, most studies have measured the variables separately. Evidence supported by some prominent learning theories and models such as the ACT, TAM and Wilson's (1992) framework, has substantiated the claim of this research that these three variables should be measured holistically.

1.1.4 Teaching Of Science And Mathematics In English Using Of ICT

The mastery of content knowledge and skills of science and technology coupled with the ability to communicate and access information effectively through English is a lethal combination that forms the basic prerequisite for national development and progress towards the status of a developed nation in 2020. Realising the importance of the ability to access the vast amount of science and technology information and the role of English in the field of science and

technology, Malaysia launched the new policy of teaching Science and Mathematics in English in its schools in 2003.

In light of the shift in medium of instruction in Mathematics and Science subjects in Malaysian schools from Malay to English beginning in 2003. The shift in medium of instruction was initiated simultaneously with the cohort of students in year 1 in the primary school, in Form 1 in the secondary school and in the lower sixth form beginning in 2003, and continued progressively in the next year/form for each of these cohorts of students. Table 1 below diagrammatically represents the progressive implementation of the shifts in medium of instruction from 2003 to 2006.

Table 1.1 Progressive Implementation In Shift Of Medium Of Instruction For Mathematics And Science Subjects In Malaysian Schools

Cohorts	Primary						Secondary				
	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	F1	F2	F3	F4	F5
2003	☑	○	○	○	○	○	☑	○	○	○	○
2004	☑	☑	○	○	○	○	☑	☑	○	○	○
2005	☑	☑	☑	○	○	○	☑	☑	☑	○	○
2006	☑	☑	☑	☑	○	○	☑	☑	☑	☑	○

Key:

☑ Mathematics and Science taught in English

○ Mathematics and Science taught in Malay

Technology use is directing schools to another promising avenue of helping pupils learn Mathematics and Science for understanding. The role of technology has been increasingly discussed in hopes of bringing students, mathematics and science together, thereby easing the process of language minority student integration into the mathematics and science classroom. Smith (1995) calls technology a great equalizer. On the other hand, it also can be argued that the competitive and impersonal atmosphere that technology may bring into the mathematics or science classroom can leave learners disoriented. Certainly technology has the potential to improve pupils' success in Mathematics and Science.

However, as the concept of being science literate is changing, technology holds promise in establishing science discourse. Today, schools are aiming at teaching children not only to be familiar with scientific terminology and textbook drills in order to be capable of applying knowledge to their individual lives, but also to recognize the diversity and unity of the natural world, understand strengths and weaknesses of technological applications, and explore scientific questions rather than get the answers right (Lee & Fradd, 1996). It's been argued that science, to any learner, is a language of its own, but research is showing evidence that technology reduces student dependency on language to some extent, bringing native and nonnative English speakers together. Further, science in general is a good medium for making the most use of technology "since so much of it is hands-on" (Harris, 1995, p. 26).

While information and communication technology (ICT) is not a panacea for all educational problems, today's technologies are essential tools for teaching and learning. To use these tools effectively and efficiently, teachers need visions of the technologies' potential, opportunities to apply them, training and just-in-time support, and time to experiment. Only then can teachers be informed and confident in their use of new technologies (Bowes, 2003).

Teaching is becoming one of the most challenging professions in our society where knowledge is expanding rapidly and much of it is available to students as well as teachers at the same time (Perraton, Robinson, & Creed, 2001). As new concepts of learning have evolved, teachers are expected to facilitate learning and make it meaningful to individual learners rather than just to provide knowledge and skills. Modern developments of innovative technologies have provided new possibilities to teaching professions, but at the same time have placed more demands on teachers to learn how to use these new technologies in their teaching (Robinson & Latchem, 2003). These challenges ask teachers to continuously retrain themselves and acquire new knowledge and skills while maintaining their jobs (Carlson & Gadio, 2002). Then what can be done to help teachers meet these challenges?

Today, a variety of ICT can facilitate not only delivery of instruction, but also learning process itself. Moreover, ICT can promote international collaboration and networking in education and professional development. There's a range of ICT

options – from videoconferencing through multimedia delivery to web sites - which can be used to meet the challenges teachers face today. In fact, there has been increasing evidence that ICT may be able to provide more flexible and effective ways for lifelong professional development for today's teachers.

Because of rapid development in ICT, especially the Internet, traditional initial teacher training as well as in-service continued training institutions worldwide are undergoing a rapid change in the structure and content of their training and delivery methods of their courses. However, combining new technologies with effective pedagogy has become a daunting task for both initial teacher training and in-service training institutions.

In the era of globalization, a nation's science, technology and education policies play a very important role in determining the economic development of the country. They form the foundation that empowers the development of all kinds of modern industries to compete in the borderless world market.

To survive and excel in the competitive global economy, our younger generation needs to master the knowledge of science and technology. Command of the lingua franca of science and technology provides the competitive edge in the competitive global economy.

1.2 Research Questions

The research questions attempt to answer the objectives of the study. The following are the questions :

1. What are the elements of ICT integrated in the Science lessons?
2. How far the elements of ICT have been integrated in the Science lessons?
3. How is the teachers' competency in computers?
4. Is there any association between teachers' computer competency and the levels in the ICT integrating in Science lessons?
5. What are the constraints encountered in the integrating the ICT elements?

1.3 Objectives Of The Study

Teacher always stands in the front line to accept any changes and evolution in the education system. He must has the fast pace to capture the changes. So, teacher must be capable and have the ability to adapt the changes. This includes the latest changes of using the computer to teach Science subject.

The objectives of the study are:

1. To identify the elements of ICT integrated in the Science lessons;
2. To find out how far the elements of ICT have been integrated in the Science lessons;
3. To identify the teachers' competency in computers;

4. To find out whether there is any significant association between teachers' computer competency and the levels in the ICT integrating in Science lessons;
5. To find out the constraints encountered in integrating the ICT elements.

4 Significance Of The Study

In order not to be left behind in the current development, especially in the education sector, Ministry of Education have to ascertain that integration of ICT in PPSMI is successfully carried out especially in the process of teaching and learning. Ministry of Education also would like the teachers to follow the guidelines in carrying out the lessons. Teachers have to carry out PPSMI using the computer as much manpower and investment has been spent in preparing and supplying the hardwares and softwares to all the schools throughout the country.

Science teachers need to have wide range of knowledge, positive attitude, enthusiasm and readiness to equip himself in the integration of ICT in the process of teaching and learning in Science. The attitude and the enthusiasm shown by teachers upon the using of computer in process of teaching and learning indirectly indicate that pupils have to learn Science using ICT. Teachers could influence pupils tremendously as far as learning is concerned. According to Sharifah Alwiah (1988), the knowledge imparted from teachers in the school will be practiced by individuals although they have left the school.

This research was carried out in the primary schools in Sarikei District. It roughly shows how far the Science teachers integrate the ICT elements in their lessons. It can be used as a reference resource and guide to the school, Divisional Education Office (PPG), Inspectorates (Jemaah Nazir) or Sarawak State Education Department.(JPNS)

With result of the study/research, it is hope that it can become the guidelines to the Science teacher, showing the real situation in the matter related to the integration of ICT elements in the process of teaching and learning. It also could be the references to Sarawak State Education Department or Ministry of Education. With that, several steps and relevant actions can be taken for example, to carry out courses or training which can tackle the needs of Science teachers to upgrade the knowledge of ICT or even the computer skills.

1.5. Definition Of Terms

The following operational definitions were used in the study.

Information Technology (IT)

Refers to all elements of technology that could retrieve, save, process, broadcast and present information. The basis of technology includes the computers,

microelectronic, telecommunication and software technology as well as other devices (Government of Malaysia, 1991). Zoraini (1993) stated that IT is a process where data is manipulated to obtain information through several methods such as collecting, storing, processing and reporting. These methods are usually done with computers. IT in this study refers to the computer, traditional computer applications and the Internet (electronic mail and the World Wide Web).

Information Technology (IT) is also the term used to describe the items of equipment (hardware) and computer programs (software) that allows us to access, retrieve, store, organise, manipulate and present information by electronic means...". Examples include: scanners, computers, projection equipment (hardware) and database, spreadsheet, and multimedia software programs (software). (Interactive Education: An Information and Communication Technologies Strategy for Schools)

Science Teachers

Science teachers in this study refer to in-service teachers. In-service teachers in this study are the teachers who had undergone formal training in teaching and are currently undergoing teacher training in a recognised teacher training institution.

Computer Knowledge

Anderson (1982) refers knowledge as declarative knowledge. It is defined as proposition about what is true. Computer knowledge in this study is defined as the number of correct answers pertaining to IT achieved as measured by the IT based instrument. The questions comprise two dimensions. The first dimension comprises content categories (system hardware, system software and the Internet) whilst the other dimension comprises three levels of Bloom's Taxonomy: factual knowledge, comprehension and application.

Computer Skills

Anderson (1983) describes skills as procedural knowledge which is the ability to carry out procedures correctly. Computer skills in this study are defined as the ability to execute specified IT tasks as measured by the IT based instrument. The tasks comprise two dimensions. The first dimension comprises five content categories (word processing, e-database, e-spreadsheet, e-presentation and the Internet) whilst the second dimension comprises three task categories (basic operations, manipulation and design) the teachers are expected to demonstrate.

Integration

In the context of Smart School, the computer integration in the teaching and learning refers to any application or usage of computer, which include the multimedia softwares and internet service, in teaching and learning to supply or support the content suitability of the lesson for the simplicity of the teaching process.

ICT

Information Communication Technologies; the term used to describe the tools and the processes to access, retrieve, store, organize, manipulate, produce, present and exchange information by electronic and other automated mean

Elements of ICT

The elements of ICT use in the integration of teaching Science are PowerPoint presentation, video, audio, database, internet, graphics, animation and teaching courseware supplied by the Ministry of Education.

1.6 Limitations Of The Study

This study is subjected to several limitations where the selected respondents and research focus are fixed to teachers teaching Science in the primary schools in the Sarikei District, Sarawak. These Science subject teachers did not take Science during their training. Many of them are in fact English and Mathematics teachers. The majority of them were in Science stream. The reasons why only choosing the Sarikei District in this research because of the time and resource constraints.

This study can not represent the present condition of integrating ICT elements in the Science subject throughout the states or country. It only can be generalised to the Science teachers in the Sarikei District, Sarawak.

1.7 Conclusion

This chapter has first briefly discussed the background of the study, the education system from primary to tertiary level. It also mentioned the latest changes in the education with the Smart schools project and using ICT in the teaching of Science and Mathematics in English. The chapter has also discussed the Research Questions, Objectives of the Study , Significance of the Study , Definition of Terms and Limitations of the Study.

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